US011353017B2

(12) United States Patent
Surjaatmadja et al.

(10) Patent No.: US 11,353,017 B2
(45) Date of Patent: Jun. 7, 2022

(54) INTENSITY MODIFIABLE INTENSIFIER PUMP

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/769,234**

(22) PCT Filed: **Feb. 14, 2018**

(86) PCT No.: **PCT/US2018/018121**

§ 371 (c)(1),
(2) Date: **Jun. 2, 2020**

(87) PCT Pub. No.: **WO2019/160538**

PCT Pub. Date: **Aug. 22, 2019**

(65) **Prior Publication Data**

US 2020/0340461 A1 Oct. 29, 2020

(51) **Int. Cl.**
F04B 49/18 (2006.01)
F04B 5/00 (2006.01)
F04B 15/02 (2006.01)

(52) **U.S. Cl.**
CPC ***F04B 49/18*** (2013.01); ***F04B 5/00*** (2013.01); ***F04B 15/02*** (2013.01)

(58) **Field of Classification Search**
CPC F04B 49/18; F04B 5/00–02; F04B 39/005; F04B 53/14; F15B 3/00; F16J 1/00–24
USPC .... 92/6 R, 6 D; 417/225–227, 238, 274
See application file for complete search history.

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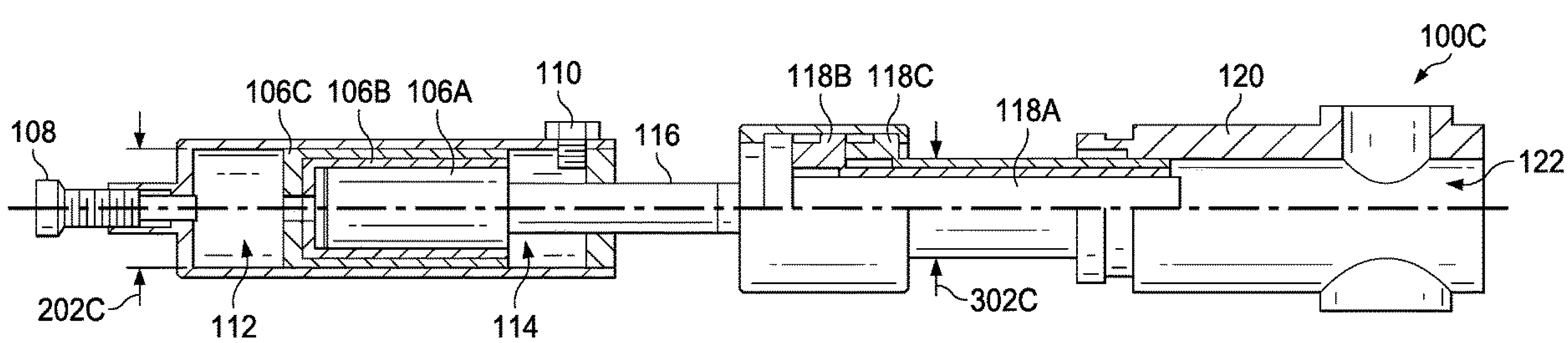
Assistant Examiner — Thomas Fink
(74) *Attorney, Agent, or Firm* — McGuireWoods LLP

(57) **ABSTRACT**

An intensifier pump includes a piston including at least two selectable piston diameters. Additionally, the intensifier pump includes a plunger that in operation interacts with the piston. The plunger includes a plunger diameter that is smaller than each of the at least two selectable piston diameters.

20 Claims, 6 Drawing Sheets



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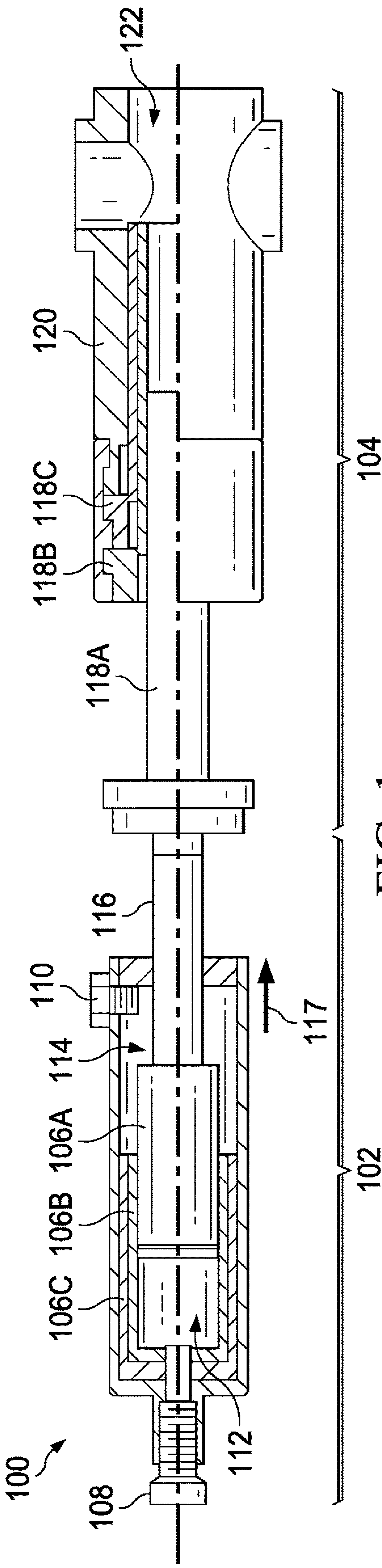

122
120
118C
118B
118A
104
116
110
114
117
106A
106B
106C
102
100
108
112

FIG. 1

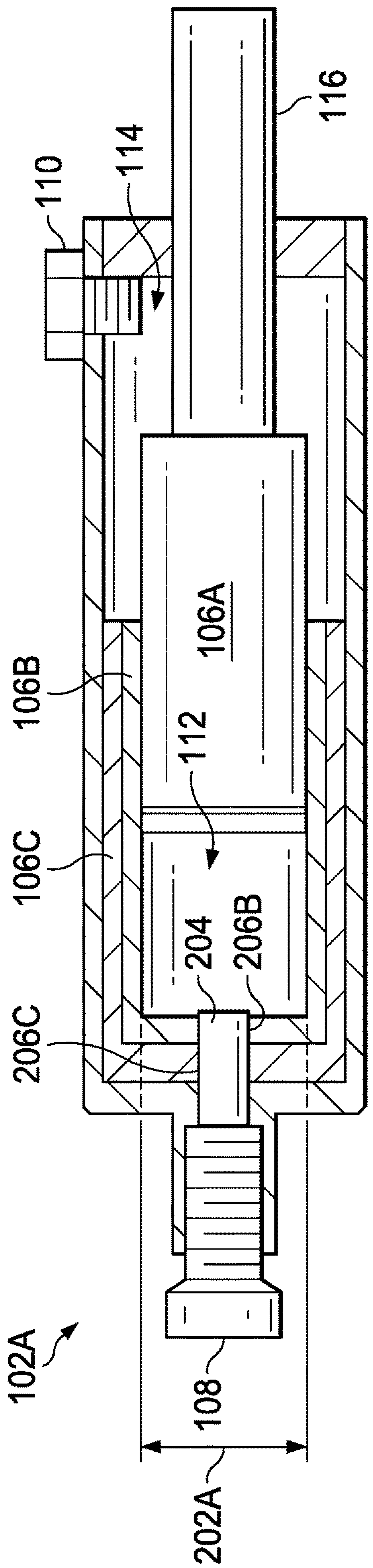

116
110
114
106A
106B
112
106C
204
206B
206C
102A
108
202A

FIG. 2A

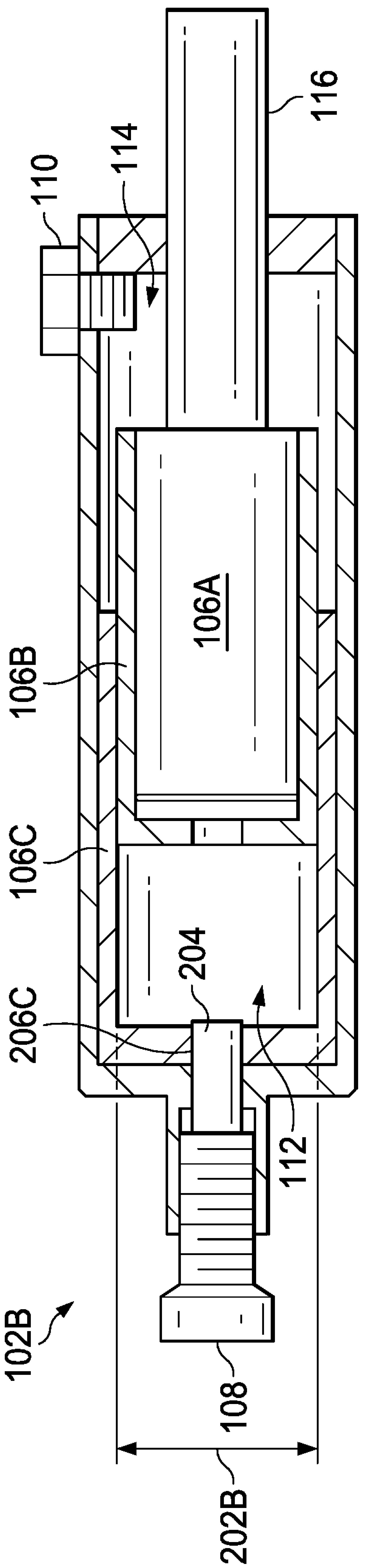

116
110
114
106A
106B
106C
206C
204
112
102B
108
202B

FIG. 2B

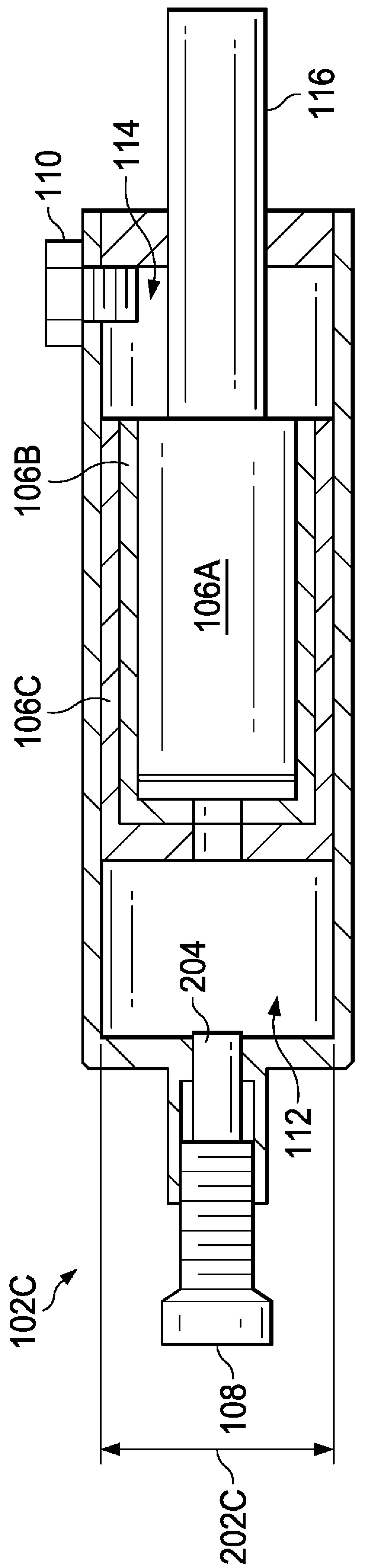

116
110
114
106B
106A
106C
204
112
102C
108
202C

FIG. 2C

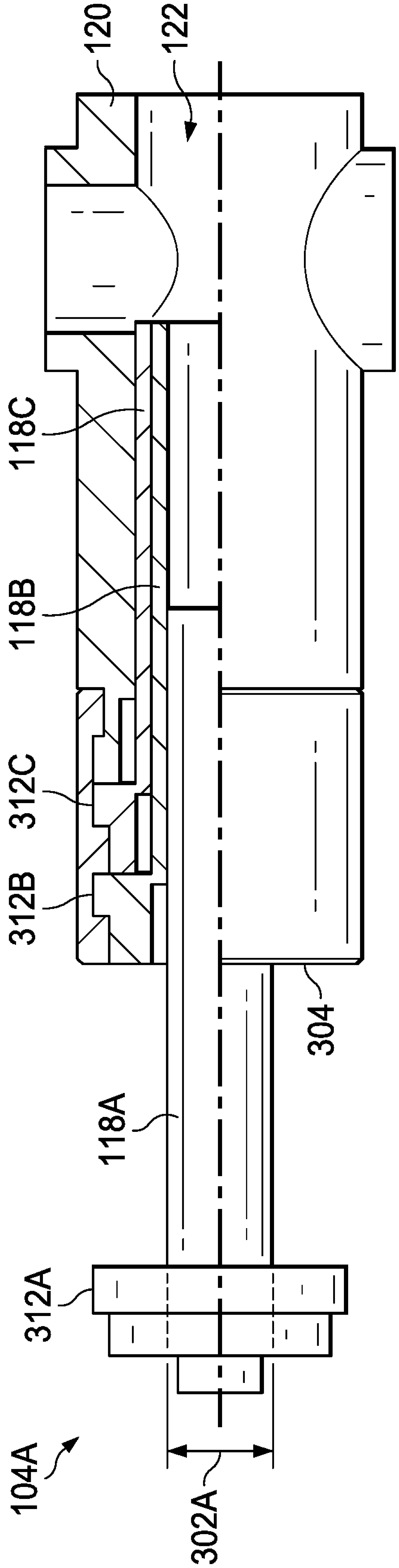

120
122
118C
118B
312C
312B
304
118A
312A
104A
302A

FIG. 3A

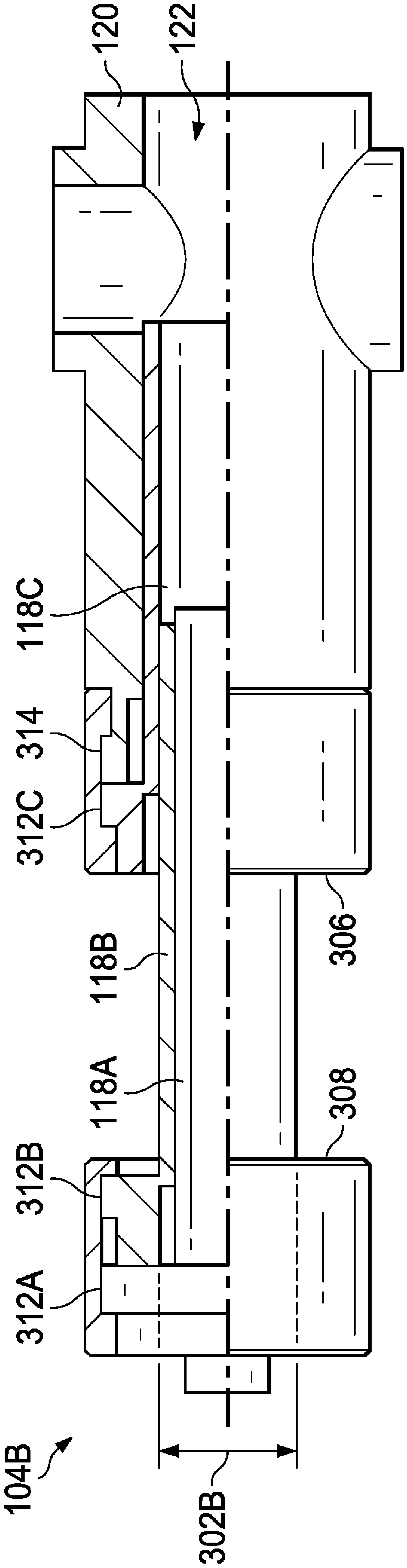

120
122
118C
314
312C
306
118B
118A
308
312B
312A
104B
302B

FIG. 3B

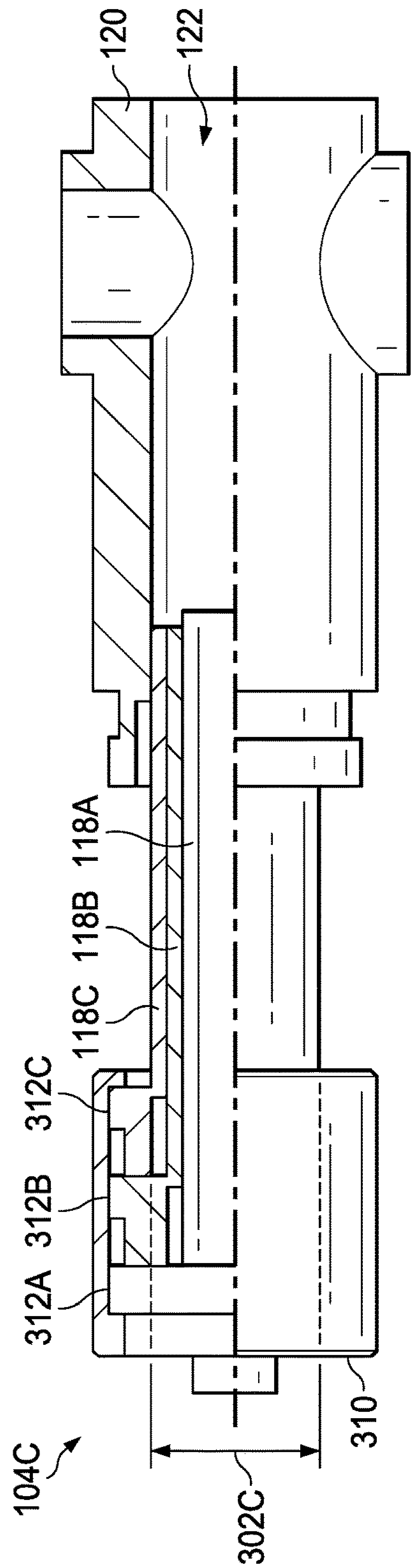

120
122
118A
118B
118C
312C
312B
312A
104C
302C
310

FIG. 3C

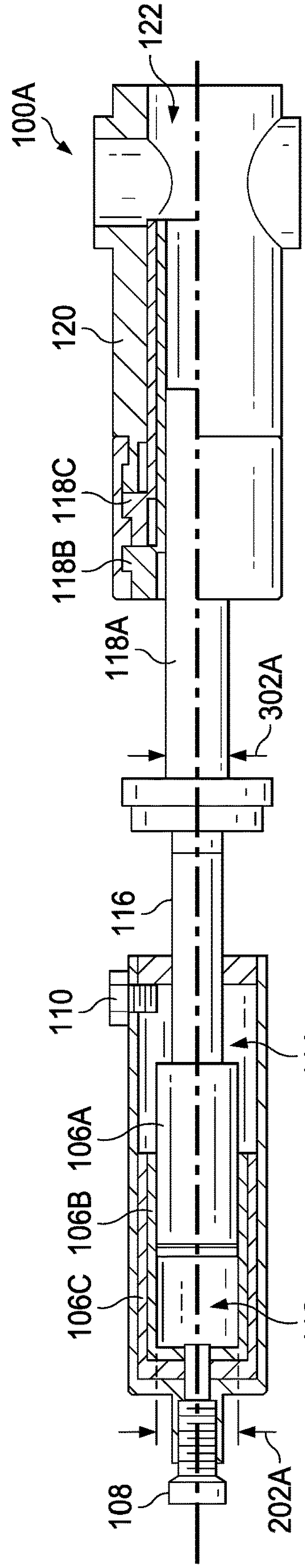
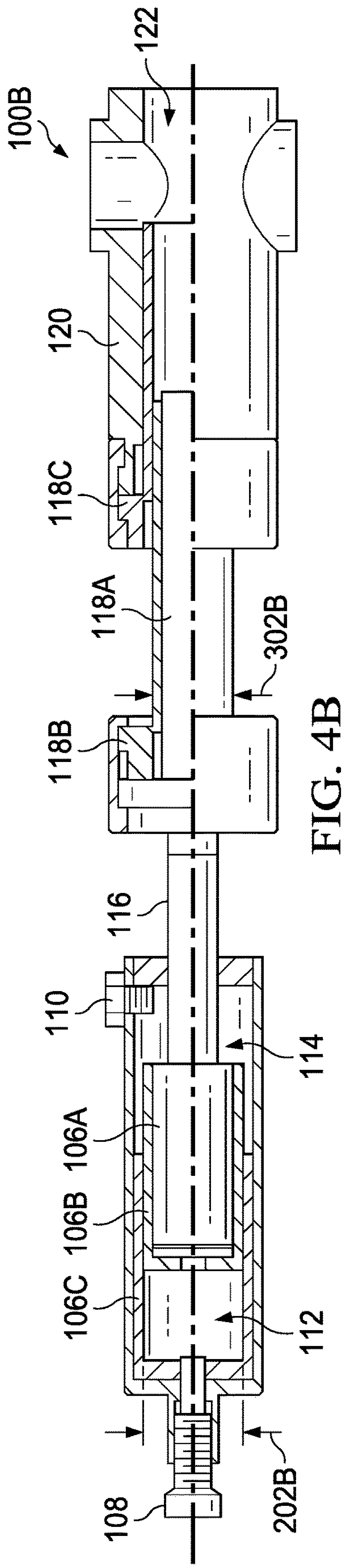
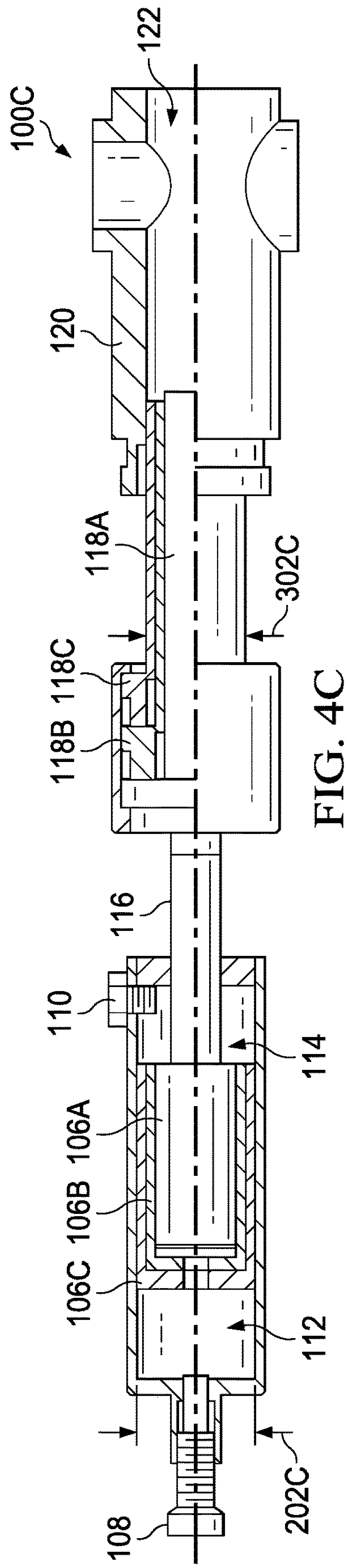

122
100A
120
118C
118B
118A
302A
116
110
114
106A
106B
106C
112
108
202A

FIG. 4A



122
100B
120
118C
118A
302B
118B
116
110
114
106A
106B
106C
112
108
202B

FIG. 4B



122
100C
120
118A
302C
118C
118B
116
110
114
106A
106B
106C
112
108
202C

FIG. 4C

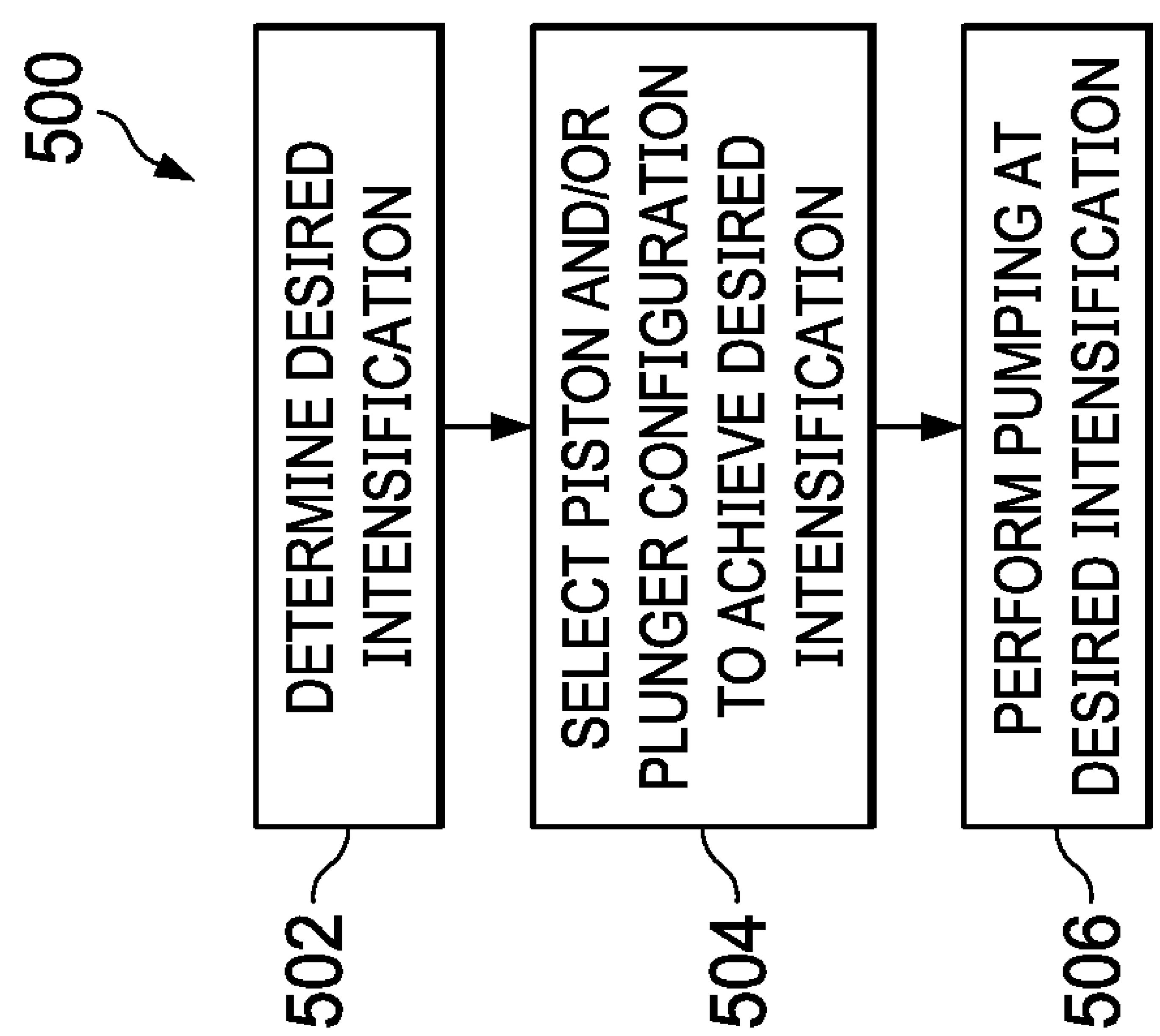

500
DETERMINE DESIRED INTENSIFICATION
502
SELECT PISTON AND/OR PLUNGER CONFIGURATION TO ACHIEVE DESIRED INTENSIFICATION
504
PERFORM PUMPING AT DESIRED INTENSIFICATION
506

FIG. 5

INTENSITY MODIFIABLE INTENSIFIER PUMP

BACKGROUND

The disclosure generally relates to intensifier pumps. More specifically, the disclosure relates to intensifier pumps including mechanisms to modify an output intensity of the intensifier pump.

Intensifier pumps are widely used in applications that rely on delivery of high pressure fluid. Generally, the intensifier pumps are tuned to provide a specific pressure ratio between a low pressure side of the intensifier pump and a high pressure side of the intensifier pump. This ratio is associated with a difference in diameter between a larger diameter low pressure piston and a smaller diameter high pressure plunger. Accordingly, if a change to an output pressure is desired, an operator is required to change the pressure of the fluid provided at the input, or to change out the intensifier pump with a different pressure ratio.

Such changes to the intensifier pump may increase costs associated with the delivery of high pressure fluid. For example, an operator may keep several intensifier pumps on site with differing pressure ratios, which leads to increased equipment costs. Additionally, the time required to replace an intensifier pump with another intensifier pump with a different pressure ratio may also contribute to an increase in personnel costs. Changing the input fluid pressure at the intensifier pump may also provide difficulties for an operator in the field when the operator desires to change the output fluid pressure without changing out the intensifier pump. For example, changing the input fluid pressure may require additional equipment, an increase in personnel costs, or both. Moreover, because the input fluid originates from a low pressure fluid line, changes to the input fluid pressure may not be practicable as other devices that operate using a certain range of fluid pressures may also be coupled to the low pressure fluid line.

BRIEF DESCRIPTION OF THE DRAWINGS

Illustrative embodiments of the present disclosure are described in detail below with reference to the attached drawing figures, which are incorporated by reference herein, and wherein:

FIG. **1** is a sectional view of an intensifier pump, in accordance with an embodiment of the disclosure;

FIGS. **2**A-**2**C are sectional views of a piston of the intensifier pump of FIG. **1** in three different intensity arrangements, in accordance with an embodiment of the disclosure;

FIGS. **3**A-**3**C are sectional views of a plunger of the intensifier pump of FIG. **1** in three different intensity arrangements, in accordance with an embodiment of the disclosure;

FIGS. **4**A-**4**C are sectional views of the intensifier pump of FIG. **1** in three different intensity arrangements, in accordance with an embodiment of the disclosure; and

FIG. **5** is a flowchart of a method of setting an intensity arrangement of the intensifier pump of FIG. **1**, in accordance with an embodiment of the disclosure.

The illustrated figures are only exemplary and are not intended to assert or imply any limitation with regard to the environment, architecture, design, or process in which different embodiments may be implemented.

DETAILED DESCRIPTION

In the following detailed description of the illustrative embodiments, reference is made to the accompanying drawings that form a part hereof. These embodiments are described in sufficient detail to enable those skilled in the art to practice the disclosed subject matter, and it is understood that other embodiments may be utilized and that logical structural, mechanical, electrical, and chemical changes may be made without departing from the spirit or scope of the disclosure. To avoid detail not necessary to enable those skilled in the art to practice the embodiments described herein, the description may omit certain information known to those skilled in the art. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the illustrative embodiments is defined only by the appended claims.

As used herein, the singular forms "a", "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprise" and/or "comprising," when used in this specification and/or the claims, specify the presence of stated features, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, steps, operations, elements, components, and/or groups thereof. In addition, the steps and components described in the embodiments and figures are merely illustrative and do not imply that any particular step or component is a requirement of a claimed embodiment.

Unless otherwise specified, any use of any form of the terms "connect," "engage," "couple," "attach," or any other term describing an interaction between elements is not meant to limit the interaction to direct interaction between the elements and may also include indirect interaction between the elements described. In the following discussion and in the claims, the terms "including" and "comprising" are used in an open-ended fashion, and thus should be interpreted to mean "including, but not limited to". Unless otherwise indicated, as used throughout this document, "or" does not require mutual exclusivity.

Further, spatially relative terms, such as beneath, below, lower, above, upper, uphole, downhole, upstream, downstream, and the like, may be used herein for ease of description to describe one element or feature's relationship to another element or feature as illustrated, the upward direction being toward the top of the corresponding figure and the downward direction being toward the bottom of the corresponding figure. Unless otherwise stated, the spatially relative terms are intended to encompass different orientations of the apparatus in use or operation in addition to the orientation depicted in the figures. For example, if an apparatus in the figures is turned over, elements described as being "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the exemplary term "below" can encompass both an orientation of above and below. The apparatus may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein may likewise be interpreted accordingly.

The present disclosure is related to intensifier pumps and, in particular, to intensifier pumps with modifiable intensities. In some embodiments, the intensifier pumps include multiple adjustable diameters of pistons and plungers that provide adjustments to intensification by the intensifier pump. The resulting intensifier pump provides an operator with the ability to change pump intensity on the fly without changing input pressure originating from a fluid line with a fixed pressure.

The devices described herein may be suitable for use in the oil and gas industry, such as for use in providing fluids downhole during fracturing operations. It will be appreciated, however, that the devices described herein are equally applicable to pumping technologies uses in other technical fields including, but not limited to, automotive, civil, marine, fabrication, water-jetting, aeronautics or medical fields and any other field where it may be desired to intensify fluid pumping pressure. Applications may also include static pressure requirements, such as presses, lifts or semi-motive applications.

Referring to FIG. **1**, illustrated is an intensifier pump **100**, according to one or more embodiments. As illustrated, the intensifier pump **100** includes a power section **102** and a pressure section **104**. The power section **102** includes a modifiable piston **106**. The modifiable piston **106** may be modified between pistons **106**A, **106**B, and **106**C with varying diameters. While three different pistons **106**A, **106**B, and **106**C are illustrated in FIG. **1**, more or fewer diameters of the piston **106** are also contemplated within the scope of the present disclosure.

An input port **108** receives energizing liquid from an input fluid line, such as a hydraulic fluid line. The energizing liquid may be hydraulic oil, water, or any other clean fluid such as antifreeze. The input port **108** may also operate as a control mandrel to control which of the pistons **106**A, **106**B, or **106**C is used during an intensifier operation. For example, an operator may move the input port **108** within the power section **102** in a direction toward the pressure section **104** to select the piston **106**A with the smallest diameter. Additionally, as the operator moves the input port **108** in a direction away from the pressure section **104**, the piston **106**B or the piston **106**C, which include progressively larger diameters, is selected.

Selecting the piston **106**B or **106**C in place of the piston **106**A results in a different intensifier ratio of the intensifier pump **100**. For example, as the diameter of the piston **106** increases, the output pressure of the intensifier pump **100** also increases. In an embodiment, the piston **106**A may provide an intensification of three times a pressure of the energizing fluid provided to the input port **108**, the piston **106**B may provide an intensification of four times a pressure of the energizing fluid provided to the input port **108**, and the piston **106**C may provide an intensification of five times a pressure of the energizing fluid provided to the input port **108** assuming that pressure section **104** remains constant.

As mentioned above, the input port **108** receives input fluid (i.e., energizer liquid) from an input fluid line (not shown). The input fluid enters the intensifier pump **100** at the input port **108**, travels to an input cavity **112**, and acts on the piston **106**A, **106**B, or **106**C that is selected by the operator based on the position of the input port **108**. As the input fluid acts on the selected piston **106**, input fluid in an exit cavity **114** is displaced and expelled through an exit port **110**. As the input fluid acts on the selected piston **106**, a rod **116** extending from the power section **102** moves in a direction **117** toward the pressure section **104**.

The pressure section **104** includes a plunger **118**. Similar to the piston **106**, the plunger **118** may also include a selectable size. For example, the plunger **118** may include three plungers **118**A, **118**B, or **118**C of different diameters that are selectable by the operator of the intensifier pump **100**. As illustrated, the plunger **118**A is a solid cylinder, while the plungers **118**B and **118**C are hollow cylinders that are progressively larger than the solid cylinder of the plunger **118**A. Accordingly, when the plunger **118**B is selected, the plunger **118**A is nested within the plunger **118**B to generate a larger diameter. Similarly, when the plunger **118**C is selected, the plungers **118**A and **118**B are nested within the plunger **118**C to generate a larger diameter. While three plungers **118**A, **118**B, and **118**C are illustrated, more or fewer plungers **118** are also contemplated within the scope of the present disclosure. As the input fluid enters the input port **108** forcing the piston **106** in the direction **117**, the rod **116** acts on the plunger **118** in the direction **117**. Because a diameter of the plunger **118** is smaller than a diameter of the piston **106**, a pressure of working fluid of the intensifier pump **100** is intensified based on a ratio of the surface areas of the piston **106** and the plunger **118**. Accordingly, as the plunger **118** moves in the direction **117** within a pump body **120** of the pressure section **104**, a pressure of the working fluid within a compression chamber **122** of the pump body **120** increases. In an embodiment, the intensifier pump **100** is capable of outputting a pressure of between 15,000 psi and 30,000 psi from the pressure section **104** of the intensifier pump **100**.

FIGS. **2**A-**2**C are a sectional views of the pistons **106**A-C of the intensifier pump **100** in three different intensity arrangements, according to one or more embodiments. By way of example, a power section **102**A includes the input port **108** in a position that selects the piston **106**A. The piston **106**A includes a diameter **202**A. The diameter **202**A is smaller than diameters **202**B and **202**C associated with pistons **106**B and **106**C, respectively. Accordingly, output pressure of the working fluid from the pressure section **104** is less using the power section **102**A than the output pressure from the pressure section **104** when using power sections **102**B and **102**C.

The power section **102**B includes the input port **108** in a position that selects the piston **106**B. The piston **106**B includes the diameter **202**B that is larger than the diameter **202**A and smaller than the diameter **202**C. The piston **106**A may fit within the piston **106**B such that the piston **106**A remains nested within the piston **106**B during operation of the intensifier pump **100** when the piston **106**B is selected by the input port **108**. In selecting the piston **106**B, the output pressure of the working fluid from the pressure section **104** will be larger than the output pressure using the power section **102**A and smaller than the output pressure using the power section **102**C.

The power section **102**C includes the input port **108** in a position that selects the piston **106**C. The piston **106**C includes the diameter **202**C that is larger than the diameters **202**A and **202**B. The pistons **106**A and **106**B may fit within the piston **106**C such that the pistons **106**A and **106**B remain nested within the piston **106**C during operation of the intensifier pump **100** when the piston **106**C is selected by the input port **108**. In selecting the piston **106**C, the output pressure of the working fluid from the pressure section **104** will be larger than the output pressure using either of the power sections **102**A or **102**B.

To select between the pistons **106**A, **106**B, and **106**C, the input port **108** may include a sealing component, such as an O-ring, in combination with a locking component that is able to lock the input port **108** to the piston **106**B or **106**C. For example, the input port **108** may be threaded along a portion **204** of the input port **108**, and the threads of the input port **108** may match threading along orifices **206**B and **206**C of the pistons **106**B and **106**C, respectively. The threading on the portion **204** of the input port **108** and within the orifices **206**B and **206**C may enable the input port **108** to lock the unwanted pistons **106**B and/or **106**C in an inoperable position, as illustrated in the power sections **102**A and **102**B. When the input port **108** does not interact with the pistons **106**B and **106**C, as in the power section **102**C, the piston **106**C is selected for operation of the intensifier pump **100**.

In the embodiments of FIGS. **2**A-**2**C, pistons are automatically locked into position by pressure differential. For example, the system is in an extended situation using all three pistons **106**A-**106**C, as illustrated in FIG. **2**C. At that instance in time, it is decided to reduce pressure capacity to the second position. The input port **108** is quickly repositioned, as represented in FIG. **2**B. No pressure change will be experienced at the pump output until the piston moves back completely, thus sealingly engages input port **108** to orifice **206**C. Now, pressurizing input port **108** will not be able to move piston **106**C anymore, as the right side of orifice **206**C is now pressurized. This means that force output of the power section **102** automatically changes at the following forward stroke following reposition of input port **108**. Backward stroke of the piston is controlled by the exit port **110**.

FIGS. **3**A-**3**C are sectional views of the plunger **118** of the intensifier pump **100** in three different intensity arrangements, according to one or more embodiments. By way of example, a pressure section **104**A includes the plunger **118**A providing the pressure on the working fluid into the pressure chamber **122**. The plunger **118**A includes a diameter **302**A. The diameter **302**A is smaller than diameters **302**B and **302**C associated with the plungers **118**B and **118**C, respectively. Accordingly, output pressure of the working fluid from the pressure section **104** is greater using the pressure section **104**A than the output pressure from the pressure sections **104**B and **104**C.

The pressure section **104**B includes the plunger **118**B and **118**A providing the pressure on the working fluid in the pressure chamber **122**. The plunger **118**B includes the diameter **302**B that is larger than the diameter **302**A and smaller than the diameter **302**C. The plunger **118**A may fit within the plunger **118**B such that the plunger **118**A remains nested within the plunger **118**B during operation of the intensifier pump **100** when the plunger **118**B is selected by an operator. In selecting the plunger **118**B, the output pressure of the working fluid from the pressure section **104**B is less than the output pressure using the pressure section **104**A and greater than the output pressure using the pressure section **104**C.

The pressure section **104**C includes the plunger **118**C, **118**A and **118**B providing the pressure on the working fluid in the pressure chamber **122**. The plunger **118**C includes the diameter **302**C that is larger than the diameters **302**A and **302**B. The plungers **118**A and **118**B may fit within the plunger **118**C such that the plungers **118**A and **118**B remain nested within the plunger **118**C during operation of the intensifier pump **100** when the plunger **118**C is selected. In selecting the plunger **118**C, the output pressure of the working fluid from the pressure section **104**C is less than the output pressure using either of the pressure sections **104**A or **104**B.

To select between the plungers **118**A, **118**B, and **118**C, fastening devices **304**, **306**, **308**, and **310**, such as c-clamps or other suitable fastening devices, interact with portions of the plungers **118**A, **118**B, and **118**C. For example, the pressure section **104**A includes the fastening device **304**, which is depicted as a c-clamp in FIG. **3**A, positioned around flanges **312**B and **312**C of the plungers **118**B and **118**C, respectively. When the fastening device **304** is positioned over the flanges **312**B and **312**C, the plunger **118**A is used to provide the output pressure to the working fluid in the pressure chamber **122**, and plungers **118**B and **118**C become part of pressure chamber **122**; thus effectively reducing the effective diameter of chamber **122** and hence increasing the pressure output of chamber **122**.

In the pressure section **104**B of FIG. **3**B, the fastening devices **306** and **308** are used to select the plunger **118**B. The fastening device **306** couples the flange **312**C to a flange **314** of the pump body **120**. In this manner, the fastening device **306** holds the plunger **118**C in a stationary positon up against the pump body **120** and, therefore, plunger **118**C becomes part of the pressure chamber **122**. Additionally, the fastening device **308** couples a flange **312**A of the plunger **118**A to the flange **312**B of the plunger **118**B. In this manner, the fastening device **308** couples the plunger **118**A to the plunger **118**B to generate the diameter **302**B.

In the pressure section **104**C of FIG. **3**C, the fastening device **310** is used to select the plunger **118**C. The fastening device **310** couples all three of the flanges **312**A, **312**B, and **312**C together to generate the diameter **302**C of the plunger **118**C. Because all three of the plungers **118**A, **118**B, and **118**C are used in the pressure section **104**C, there is no fastening device to couple any of the plungers to the pump body **120**. While FIGS. **3**A-**3**C depict the fastening devices **304**, **306**, **308**, and **310** as c-clamps or sleeves that fit around the flanges **312**A-**312**C and **314**, any other suitable fastening devices are also contemplated within the scope of the present disclosure.

FIGS. **4**A-**4**C are sectional views of the intensifier pump **100** in three different intensity arrangements, according to one or more embodiments. While FIGS. **4**A-**4**C provide three different intensity arrangements, a total of nine intensity arrangements are available when the intensifier pump **100** has three separate diameters **202**A-**202**C of the piston **106** and three separate diameters **302**A-**302**C of the plunger **118**. Additionally, other embodiments of the intensifier pump **100** may include more or fewer diameters **202** for the piston **106** and more or fewer diameters **302** of the plunger **118**. For example, in an embodiment, the intensifier pump **100** may include five diameters **202** of the piston **106** and two diameters **302** of the plunger **118**. In such an embodiment, the intensifier pump **100** includes ten intensity arrangements.

As illustrated in FIGS. **4**A-**4**C, the intensifier pump **100**A includes selection of the piston **106**A and the plunger **118**A. That is, the intensifier pump **100**A includes an intensifier arrangement with the smallest diameter **202**A of the piston **106** and the smallest diameter **302**A of the plunger **118**. The intensifier pump **100**B includes selection of the piston **106**B and the plunger **118**B. That is, the intensifier pump **100**B includes an intensifier arrangement with the mid-size diameter **202**B of the piston **106** and the mid-size diameter **302**B of the plunger **118**. The intensifier pump **100**C includes selection of the piston **106**C and the plunger **118**C. That is, the intensifier pump **100**C includes an intensifier arrangement with the largest diameter **202**C of the piston **106** and the largest diameter **302**C of the plunger **118**. While only three embodiments are illustrated in FIGS. **4**A-**4**C, other arrangements are also contemplated within the scope of this disclosure. For example, the piston **106**A may be paired with any of the plungers **118**A-**118**C, the piston **106**B may be paired with any of the plungers **118**A-**118**C, and the piston **106**C may be paired with any of the plungers **118**A-**118**C.

FIG. **5** is a flowchart of a method **500** of setting an intensity arrangement of the intensifier pump **100**, in accordance with one or more embodiments of the disclosure. Initially, at block **502**, a desired intensification is determined. By way of example, an operator may decide on a pressure of the working fluid to be approximately 20,000 psi.

Subsequently, at block **504**, configuration of the piston **106** and/or plunger **118** of the intensifier pump may be selected to generate the 20,000 psi pressure. For example, when the pressure of the hydraulic fluid entering the power section **102** is 5,000 psi, to achieve the 20,000 psi pressure of the working fluid, a 4 to 1 ratio between a surface area of the piston **106** to the surface area of the plunger **118** may be selected. That is, the piston **106** is selected with a surface area four times greater than a surface area of the selected plunger **118**. Other pressures and ratios are also contemplated within the scope of the present disclosure. At block **506**, pumping of the intensifier pump **100** is performed at the selected intensification level.

In one or more embodiments, only the piston **106** or the plunger **118** may have multiple selectable diameters **202** or **302**, respectively. In such an embodiment, the method **500** may rely on only changes to the piston diameter **202** or to the plunger diameter **302** to produce the desired pressure ratio. Further, selection of the piston **106** and/or the plunger **118** to achieve a desired pressure ratio may be accomplished using an automated system. That is, a processor may receive instructions that in operation cause the processor to identify the appropriate piston **106** and/or plunger **118**, and to instruct a mechanism to physically select the identified piston **106** and/or plunger **118**. It is also possible that only one portion of the combined system is selected without implementing the other. The adjustability of the piston is simple, so it may be selected on its own without the improvement of the pressure end, i.e., the plunger modifications. However, a mechanical connection using clamps may be considered more reliable, as it is fixed for a desired duration.

It is understood that any specific order or hierarchy of steps in the processes disclosed is an illustration of exemplary approaches. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged, or that all illustrated steps be performed. Some of the steps may be performed simultaneously. Moreover, the separation of various system components in the embodiments described above should not be understood as requiring such separation in all embodiments.

Furthermore, the exemplary methodologies described herein may be implemented by a system including processing circuitry or a computer program product including instructions which, when executed by at least one processor, causes the processor to perform any of the methodology described herein.

The above-disclosed embodiments have been presented for purposes of illustration and to enable one of ordinary skill in the art to practice the disclosure, but the disclosure is not intended to be exhaustive or limited to the forms disclosed. Many insubstantial modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the disclosure. For instance, although the flowchart depicts a serial process, some of the steps/processes may be performed in parallel or out of sequence, or combined into a single step/process. The scope of the claims is intended to broadly cover the disclosed embodiments and any such modification. Further, the following clauses represent additional embodiments of the disclosure and should be considered within the scope of the disclosure:

Clause 1, an intensifier pump, comprising: a piston comprising at least two selectable piston diameters; and a plunger configured to interact with the piston, wherein the plunger comprises a plunger diameter that is smaller than each of the at least two selectable piston diameters.

Clause 2, the intensifier pump of clause 1, wherein the plunger comprises a second selectable plunger diameter that is smaller than each of the at least two selectable piston diameters.

Clause 3, the intensifier pump of clause 1 or 2, wherein the at least two selectable piston diameters comprise a first piston diameter and a second piston diameter, and wherein the first piston diameter generates a first output pressure at the plunger four times greater than an input pressure of an energizing fluid, and the second piston diameter generates a second output pressure at the plunger five times greater than the input pressure of the energizing fluid.

Clause 4, the intensifier pump of at least one of clauses 1-3, comprising: an input port, wherein the input port is configured to select between the at least two selectable piston diameters.

Clause 5, the intensifier pump of at least one of clauses 1-4, wherein the input port selects between the at least two selectable piston diameters by moving toward the plunger or away from the plunger.

Clause 6, the intensifier pump of at least one of clauses 1-5, wherein the input port comprises threading at one end, and the threading is configured to interact with the piston to select between the at least two selectable piston diameters.

Clause 7, the intensifier pump of at least one of clauses 1-6, wherein the input port is configured to receive energizing liquid from a hydraulic fluid line that provides hydraulic pressure to the piston.

Clause 8, the intensifier pump of at least one of clauses 1-7, wherein the piston comprises a first piston body with a first piston diameter and a second piston body with a second diameter, wherein the first piston body is configured to nest within the second piston body.

Clause 9, the intensifier pump of at least one of clauses 1-8, wherein the piston comprises a first piston body, a second piston body, and a third piston body, and the first piston body and the second piston body are configured to nest within the third piston body.

Clause 10, the intensifier pump of at least one of clauses 1-9, wherein the plunger is configured to output pressure up to 30,000 psi.

Clause 11, an intensifier pump, comprising: an input port to receive input fluid; a piston comprising a piston diameter; and a plunger configured to interact with the piston, wherein the plunger comprises at least two selectable plunger diameters and each of the at least two selectable plunger diameters is smaller than the piston diameter.

Clause 12, the intensifier pump of clause 11, wherein the plunger comprises a set of flanges, and the at least two selectable plunger diameters are selectable using a clamp interacting with the set of flanges.

Clause 13, the intensifier pump of clause 11 or 12, wherein the plunger comprises a solid cylinder of a first diameter and a hollow cylinder of a second diameter, wherein the solid cylinder is configured to nest within the hollow cylinder to provide the plunger with the second diameter.

Clause 14, the intensifier pump of at least one of clauses 11-13, wherein the solid cylinder comprises a first flange and the hollow cylinder comprises a second flange, and wherein the second diameter is selected by clamping the first flange to the second flange.

Clause 15, the intensifier pump of at least one of clauses 11-14, wherein the plunger is configured to output pressure up to 30,000 psi.

Clause 16, an intensifier pump, comprising: an inlet configured to receive inlet fluid at a first pressure; a piston comprising at least two selectable piston diameters, wherein the inlet fluid exerts pressure on the piston; a plunger configured to interact with the piston, wherein the plunger comprises at least two selectable plunger diameters and each of the at least two selectable plunger diameters is smaller than each of the at least two selectable piston diameters; and an outlet configured to output an outlet fluid at a second pressure greater than the first pressure, wherein the plunger exerts the second pressure on the outlet fluid.

Clause 17, the intensifier pump of clause 16, wherein the inlet is configured to select between the at least two selectable piston diameters.

Clause 18, the intensifier pump of clause 16 or 17, wherein the plunger comprises a first flange associated with a first selectable plunger diameter and a second flange associated with a second selectable plunger diameter, and the at least two selectable plunger diameters are selected by clamping and unclamping the first flange and the second flange.

Clause 19, the intensifier pump of at least one of clauses 16-18, wherein the second pressure is between 15,000 psi and 30,000 psi.

Clause 20, An intensifier pump, comprising an inlet configured to receive an inlet fluid at a first pressure; and a piston comprising at least two selectable piston diameters, and the inlet fluid exerting pressure on the piston at the first pressure; an inlet mandrel adjustable to connect to a specific one of the at least two piston diameters; and a plunger configured to interact with the piston.

While this specification provides specific details related to intensifier pumps, it may be appreciated that the list of components is illustrative only and is not intended to be exhaustive or limited to the forms disclosed. Other components related to the intensifier pumps will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the disclosure. Further, the scope of the claims is intended to broadly cover the disclosed components and any such components that are apparent to those of ordinary skill in the art.

It should be apparent from the foregoing disclosure of illustrative embodiments that significant advantages have been provided. The illustrative embodiments are not limited solely to the descriptions and illustrations included herein and are instead capable of various changes and modifications without departing from the spirit of the disclosure.

What is claimed is:

1. An intensifier pump, comprising:

a piston comprising at least two selectable piston diameters;

an inlet mandrel, wherein the inlet mandrel is configured to select between the at least two selectable piston diameters: and

a plunger configured to interact with the piston, wherein the plunger comprises a plunger diameter that is smaller than each of the at least two selectable piston diameters.

2. The intensifier pump of claim **1**, wherein the at least two selectable piston diameters comprise a first piston diameter and a second piston diameter, and wherein the first piston diameter generates a first output pressure at the plunger four times greater than an input pressure of an energizing fluid, and the second piston diameter generates a second output pressure at the plunger five times greater than the input pressure of the energizing fluid.

3. The intensifier pump of claim **1**, wherein the inlet mandrel selects between the at least two selectable piston diameters by moving toward the plunger or away from the plunger.

4. The intensifier pump of claim **1**, wherein the inlet mandrel comprises threading at one end, and the threading is configured to interact with the piston to select between the at least two selectable piston diameters.

5. The intensifier pump of claim **1**, wherein the inlet mandrel is configured to receive energizing liquid from a hydraulic fluid line that provides hydraulic pressure to the piston.

6. The intensifier pump of claim **1**, wherein the piston comprises a first piston body with a first piston diameter and a second piston body with a second diameter, wherein the first piston body is configured to nest within the second piston body.

7. The intensifier pump of claim **1**, wherein the piston comprises a first piston body, a second piston body, and a third piston body, and the first piston body and the second piston body are configured to nest within the third piston body.

8. The intensifier pump of claim **1**, wherein the plunger is configured to output pressure up to 30,000 psi.

9. A kit for selectively adjusting the output pressure of an intensifier pump, comprising:

an intensifier pump, comprising:

an input port to receive input fluid;

a piston comprising a piston diameter; and

a plunger configured to interact with the piston, wherein the plunger comprises at least two selectable plunger diameters and each of the at least two selectable plunger diameters is smaller than the piston diameter, the at least two selectable plunger diameters comprising a first plunger diameter and a second plunger diameter, and the plunger comprises a set of flanges, each of the set of flanges being capable of moving together with a stroke movement of the plunger, and

a plurality of clamps configured to interact with the flanges to selectively enable the plunger to reciprocate with the first plunger diameter or the second plunger diameter.

10. The intensifier pump of claim **9**, wherein the plunger comprises a solid cylinder of the first plunger diameter and a hollow cylinder of the plunger second diameter, wherein the solid cylinder is configured to nest within the hollow cylinder to provide the plunger with the second plunger diameter.

11. The intensifier pump of claim **10**, wherein the solid cylinder comprises a first flange of the set of flanges and the hollow cylinder comprises a second flange of the set of flanges, and wherein the second diameter is selected by clamping the first flange to the second flange.

12. The intensifier pump of claim **9**, wherein the plunger is configured to output pressure up to 30,000 psi.

13. A kit for selectively adjusting the output pressure of an intensifier pump, comprising:

the intensifier pump, the intensifier pump comprising:

an inlet mandrel configured to receive inlet fluid at a first pressure; wherein the inlet mandrel is configured to select between at least two selectable piston diameters;

a piston comprising the at least two selectable piston diameters, wherein the inlet fluid exerts pressure on the piston;

a plunger configured to interact with the piston, wherein the plunger comprises at least two selectable plunger diameters and each of the at least two selectable plunger diameters is smaller than each of the at least two selectable piston diameters, the at least two selectable plunger diameters comprising a first plunger diameter and a second plunger diameter, and

an outlet configured to output an outlet fluid at a second pressure greater than the first pressure, wherein the plunger exerts the second pressure on the outlet fluid, and

a plurality of fastening devices configured to selectively enable the plunger to reciprocate with the first plunger diameter or the second plunger diameter.

14. The intensifier pump of claim **13**, wherein the plunger comprises a first flange associated with a first selectable plunger diameter and a second flange associated with a second selectable plunger diameter, and the at least two selectable plunger diameters are selected by clamping and unclamping the first flange and the second flange.

15. The intensifier pump of claim **13**, wherein the second pressure is between 15,000 psi and 30,000 psi.

16. An intensifier pump, comprising:

an inlet configured to receive an inlet fluid at a first pressure;

a piston comprising at least two selectable piston diameters, and the inlet fluid exerting pressure on the piston at the first pressure;

an inlet mandrel adjustable to connect to a specific one of the at least two piston diameters to select the specific one of the at least two piston diameters; and

a plunger configured to interact with the piston.

17. The intensifier pump of claim **16**, wherein the input mandrel selects between the at least two selectable piston diameters by moving toward the plunger or away from the plunger.

18. The intensifier pump of claim **16**, wherein the input mandrel comprises threading at one end, and the threading is configured to interact with the piston to select between the at least two selectable piston diameters.

19. The intensifier pump of claim **16**, wherein the input mandrel is configured to receive energizing liquid from a hydraulic fluid line that provides hydraulic pressure to the piston.

20. The intensifier pump of claim **16**, wherein the piston comprises a first piston body with a first piston diameter and a second piston body with a second diameter, wherein the first piston body is configured to nest within the second piston body.

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